What is claimed is:

1. An arc fault detector for a power line system, comprising an upstream/downstream discriminator circuit, wherein said discriminator circuit detects when steps in a magnitude of a load current and steps in a magnitude of a line voltage are in phase for upstream transient events, and out of phase for downstream transient events.

2. An arc fault detector as in claim 1, wherein said transient events produce a high frequency spectrum.

3. An arc fault detector as in claim 1, wherein said transient events produce a low frequency spectrum.

4. An arc fault detector as in claim 1 wherein said steps in load current are detected with a current transformer.

5. An arc fault detector as in claim 1 wherein said steps in load current are detected across an impedance connected in series with said power line.

6. An arc fault detector as in claim 1, wherein said steps in line voltage are detected with a high pass filter connected across said power line.

7. An arc fault detector as in claim 1, wherein said steps in load current produced by steps in line voltage are connected to at least one input of a microprocessor.

8. An arc fault detector as in claim 1, wherein said out of phase steps in line voltage and load current are produced by a line voltage drop across an upstream line impedance.

9. An arc fault detector as in claim 8, wherein said line impedance is the inherent line impedance of said power line.

10. An arc fault detector as in claim 8, wherein said line impedance is an impedance introduced within said power line.

Sub A2

11. An arc fault protection device, protective of a branch circuit portion of a power line electrical distribution system and connected to a load, comprising:

a first sensor for detecting fluctuations in load current;

a second sensor for detecting fluctuations in line voltage; and

a discriminator for comparing the polarities of said fluctuations;

wherein said comparison indicates whether an arc fault or arc mimicking noise is located in said branch circuit portion or located in a remainder of said electrical distribution system.

12. The device according to claim 11, further comprising an interrupting mechanism responsive to a signal from said discriminator, wherein said interrupting mechanism does not disconnect said load from said electrical distribution system when said arc fault is located in said remainder of said electrical distribution system.

13. The device according to claim 11, wherein said first and second sensors detect fluctuations in load current or line voltage, respectively, as step changes, wherein those arc faults occurring in said protected branch circuit portion produce contrary step directions with respect to those arc faults occurring in said remainder of said electrical distribution system.

14. The device according to claim 13, wherein said first sensor is a di/dt sensor and said second sensor is a dv/dt sensor.

15. The device according to claim 14, wherein said di/dt sensor converts said current steps into di/dt pulses and said dv/dt sensor converts said voltage steps into dv/dt pulses, wherein a direction of said steps is identifiable from polarities of leading edges of said pulses.

16. The device according to claim 15, wherein an arrival of one of a di/dt pulse and a dv/dt pulse initiates a predetermined polling interval, within which interval an occurrence of an other of said di/dt pulse and said dv/dt pulse is used by said discriminator to establish a location of said arc fault within said electrical distribution system.

17. The device according to claim 16, wherein said predetermined polling interval is followed by a predetermined quiet period during which an absence of di/dt or dv/dt pulses is a prerequisite for initiating a next polling interval.

18. The device according to claim 15, further comprising a clamp for mitigating an erroneous signal following said leading edges of said di/dt or dv/dt pulses.

19. The device according to claim 18, wherein said erroneous signal is an oscillatory ringing from one of said first and second sensors.

20. The device according to claim 15, further comprising a gate, wherein an absence of said dv/dt pulses prevents said gate from delivering said di/dt pulses to said discriminator.

21. The device according to claim 15, wherein said di/dt or dv/dt pulses are exclusively arc cessation pulses.

22. The device according to claim 21, further comprising at least one of a zero cross current detector and zero cross voltage detector for characterizing one of line current and line voltage respectively, wherein said discriminator determines a plurality of phase angles of said di/dt or dv/dt pulses with respect to a zero crossing signal, and wherein arc cessation pulses are those pulses that occur within a predetermined range of said plurality of phase angles.

23. The device according to claim 22, wherein arc cessation pulses are those pulses that occur during each half cycle subsequent to a peak current or voltage.

24. The device according to claim 11, wherein said discriminator is a microprocessor.

25. The device according to claim 24, further comprising first and second hold circuits, wherein said current fluctuation signal and voltage fluctuation signal are held for pre-determined times in said first and second hold circuits, respectively, to allot said microprocessor sufficient time to recognize said fluctuations.

26. The device according to claim 11, wherein said load is an inductive load, and said device further comprises:

a line voltage zero cross detector; and

a load current zero cross detector;

wherein said zero cross detectors determine a phased relationship between line voltage and load current, and wherein said discriminator uses voltage fluctuations, current fluctuations, and said phased relationship to determine whether an arc fault or arc mimicking noise is located in said branch circuit portion or located in said remainder of said electrical distribution system.

27. The device according to claim 26, further comprising an interrupting mechanism responsive to a signal from said discriminator, wherein said interrupting mechanism does not disconnect said load from said electrical distribution system when said arc fault is located in said remainder of said electrical distribution system.

28. The device according to claim 11, further comprising at least one of a line voltage analog to digital converter connected to said line voltage sensor and a load current analog to digital converter (ADC) connected to said load current sensor;

wherein said discriminator receives signal from at least one of said analog to digital converters;

wherein said fluctuations in said load current or said line voltage, respectively, are determined using area comparison of half cycles of the power line frequency, and

wherein those arc faults occurring in said protected branch circuit portion produce contrary changes in current and voltage areas with respect to those arc faults occurring in said remainder of said electrical distribution system.

29. The device according to claim 28, wherein said load is an inductive load and said device further comprises:

a voltage zero cross detector; and

a current zero cross detector;

wherein said half cycle periods are identified by said zero cross detectors, said voltage and current half cycle periods being in phased relationship dependent on said load.

30. The device according to claim 28, further comprising an interrupting mechanism responsive to a signal from said discriminator, wherein said interrupting mechanism does not disconnect said load from said electrical distribution system when said arc fault is located in said remainder of said electrical distribution system.

31. The device according to claim 11, wherein said fluctuations in load current are sensed across an impedance inserted in series with the line.

32. The device according to claim 31, wherein said impedance is a resistance.

33. The device according to claim 11, where said fluctuations in line voltage are sensed from an output of a high pass filter.

34. The device according to claim 11, further comprising means for introducing impedance in series with said power line, wherein a fluctuation in load current produces an enhanced fluctuation in line voltage.

35. The device according to claim 34, wherein said introduced impedance is located in a separate housing apart from said device.

36. The device according to claim 11, wherein said device is responsive to voltage and current fluctuations occurring during either polarity of the power line frequency.

37. The device according to claim 11, further comprising a gate, wherein absence of a voltage fluctuation signal opens said gate to prevent delivery of a current fluctuation signal to said discriminator.

38. The device according to claim 11, wherein said current fluctuations and voltage fluctuations are exclusively associated with arc extinguishing.

39. The device according to claim 38, further comprising at least one of a zero cross current detector and a zero cross voltage detector for characterizing line current and line voltage respectively;

wherein said discriminator determines a plurality of phase angles of voltage fluctuation and current fluctuation events with respect to a zero crossing signal; and

wherein arc cessation fluctuations are those that occur within a predetermined range of said plurality of phase angles.

40. The device according to claim 39, wherein arc cessation fluctuations are those that occur during each half cycle subsequent to a peak current or voltage.

Sub B3

41. An arc fault protection device, protective of a branch circuit portion of an electrical distribution system and connected to a load, comprising:

means for detecting fluctuations in load current;

means for detecting fluctuations in line voltage; and

means for comparing the polarities of said fluctuations;

wherein said comparison is indicative of whether an arc fault signature indicative of a potential arc fault is located in said branch circuit portion or located in a remainder of said electrical distribution system.

42. A method for protecting a branch circuit portion of an electrical distribution system from an arc fault, said branch circuit portion being connected to a load, comprising the steps of:

detecting fluctuations in load current;

detecting fluctuations in line voltage; and

comparing the polarities of said fluctuations;

wherein the step of comparing indicates whether an arc fault or arc mimicking noise is located in said branch circuit portion or located in a remainder of said electrical distribution system.

A3 Cont

43. An arc fault protection device, protective of a branch circuit portion of an electrical distribution system and connected to a load, comprising:

a high frequency portion which looks at instantaneous changes on a voltage wave and a current wave of said system, wherein a relationship between said instantaneous changes indicates whether a transient is upstream or downstream; and

a low frequency portion which looks for a change in a fundamental frequency of said system and for changes in a plurality of harmonics of said fundamental frequency, wherein a sudden increase in said voltage wave accompanied by a sudden increase in said current wave indicates that said transient is upstream, and wherein a sudden increase in said voltage wave not accompanied by a sudden increase in said current wave indicates that said transient is downstream.

44. The device according to claim 43, wherein said plurality of harmonics includes a range from said fundamental frequency through its 10^{th} harmonic.

Sub A4)

45. A method for protecting a branch circuit portion of an electrical distribution system from an arc fault, said branch circuit portion being connected to a load, comprising the steps of:

high frequency filtering a voltage wave and a current wave of said system;

determining whether a relationship exists between instantaneous changes on said high frequency filtered voltage wave and said high frequency filtered current

wave of said system, and if so, whether said relationship indicates whether a transient is upstream or downstream;

low frequency filtering said voltage wave and said current wave of said system; and

determining whether a change in a fundamental frequency of said system and a change in a plurality of harmonics of said fundamental frequency occur, wherein a sudden increase in said low frequency filtered voltage wave accompanied by a sudden increase in said low frequency filtered current wave indicates that said transient is upstream, and wherein a sudden increase in said low frequency filtered voltage wave not accompanied by a sudden increase in said low frequency filtered current wave indicates that said transient is downstream.

46. An arc fault detector for a power line system, comprising:

an upstream/downstream discriminator circuit;

wherein during intervals when a line voltage and a line current are of a same polarity, said discriminator circuit detects when steps in load current and steps in line voltage are in phase for upstream caused transient events, and out of phase for downstream caused transient events; and

wherein during intervals when said line voltage and said line current are of opposite polarity, said discriminator circuit detects when steps in load current and steps in line voltage are out of phase for upstream caused transient events, and in phase for downstream caused transient events.

47. An arc fault detector as in claim 46, wherein said transient events produce a high frequency spectrum.

48. An arc fault detector as in claim 46, wherein said transient events produce a low frequency spectrum.

49. An arc fault detector as in claim 46 wherein said steps in load current are detected with a current transformer.

50. An arc fault detector as in claim 46 wherein said steps in load current are detected across an impedance connected in series with said power line.

51. An arc fault detector as in claim 46, wherein said steps in line voltage are detected with a high pass filter connected across said power line.

52. An arc fault detector as in claim 46, wherein said steps in load current produced by steps in line voltage are connected to at least one input of a microprocessor.

53. An arc fault detector as in claim 46, wherein said out of phase steps in line voltage and load current are produced by a line voltage drop across an upstream line impedance.

54. An arc fault detector as in claim 53, wherein said line impedance is the inherent line impedance of said power line.

55. An arc fault detector as in claim 53, wherein said line impedance is an impedance introduced within said power line.